Canada. Geological Survey

GEOLOGICAL SURVEY OF CANADA

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MINERAL RESOURCES OF CANADA

[No. 5]

[Bulletin on]

SALT

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GEOLOGICAL SURVEY OF CANADA,
OTTAWA, January 9, 1904.

To Dr. ROBERT BELL, L.L. D., F.R.S., &c.,
Acting Director.

SIR :—The following pamphlet dealing with the salt industry and salt fields of Canada is reprinted from the Annual Report of the Mines Section for 1902, constituting Part S. Vol. XV, N.S., of the Annual Report of the Geological Survey Department.

Pursuant to a policy suggested some years ago and now carried out with your permission, this report is one of a series of similar bulletins intended to give in condensed and popular form, information regarding the mineral resources and possibilities of the country, together with any data regarding similar occurrences in other countries when such may seem to be of use to prospectors and operators in Canada.

I am, sir,
Your obedient servant,

ELFRIC DREW INGALL,
Mining Engineer in Charge.

MINES SECTION.

SALT

Salt.

Production.

The production of salt in Ontario in 1902 from the deposits in the counties of Essex, Lambton, Middlesex, Huron and Bruce, reached a total, according to returns from operators, of 64,456 tons, valued at $292,581, exclusive of packages. The total value of packages used was $109,757.

Although the production for the year under consideration has been the largest recorded, the variation from year to year has been comparatively small, as a glance at Table 1 will show.

The output of salt in 1886 was 62,359 tons and in only five years between that year and the present time has the output been less than 50,000 tons.

Ontario is the only province at present producing salt. In 1896 a few tons were manufactured at the south end of Lake Winnipegosis, Manitoba, but the industry has not been followed up in this district. Small quantities of brine have occasionally been evaporated at Plumweseep, N.B., and sold locally along the line of the Intercolonial Railway, but these operations have apparently ceased since 1898.

The exports of salt, which are of small amount, are shown in Table No. 2. Tables Nos. 3 and 4 show the quantities and values of the salt imported. The value of the salt imported, on which a customs duty is levied, has ranged from $20,000 to $80,000 a year, the value in 1902 being $39,605. Salt imported from the United Kingdom or any British possession, or imported for the use of the sea or gulf fisheries, is free of duty, and a large proportion of the trade of eastern Canada is supplied with salt imported under this class. The quantity imported duty free in 1902 was 119,324 tons, valued at $385,629.

Salt.

Production.

TABLE 1.

SALT.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.
1886	62,359	$227,195
1887	60,173	166,394
1888	59,070	185,460
1889	32,832	129,547
1890	43,754	198,857
1891	45,021	161,179
1892	45,486	162,041
1893	62,324	195,926
1894	57,199	170,687
1895	52,376	160,455
1896	43,960	169,693
1897	51,348	225,730
1898	57,142	248,639
1899	59,339	254,390
1900	62,055	279,458
1901	59,428	262,328
1902	64,456	292,581

Exports.

TABLE 2.

SALT.

EXPORTS.

Calendar Year.	Bushels.	Value.
1880	467,641	$46,211
1881	343,208	44,627
1882	181,758	18,350
1883	199,733	19,492
1884	167,029	15,291
1885	246,794	18,756
1886	224,943	16,886
1887	154,045	11,526
1888	15,251	3,987
1889	8,557	2,390
1890	6,605	1,667
1891	5,290	1,277
1892	2,000	504
1893	4,940	1,267
1894	4,639	1,120
1895	4,865	959
1896	3,842	899
1897	5,383	1,193
1898	5,202	1,252
1899	11,205	2,773
1900	37,653	8,997
1901	39,224	6,510
1902	9,331	3,798

Salt.
Imports.

TABLE 3.

SALT.

IMPORTS :—SALT PAYING DUTY.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880	726,640	$ 3,916	1891	15,140,827	$59,311
1881	2,588,465	6,355	1892	18,648,191	65,963
1882	3,679,415	12,318	1893	21,377,339	79,838
1883	12,136,968	36,223	1894	15,867,825	53,336
1884	12,770,950	38,949	1895	8,498,404	29,881
1885	10,397,761	31,726	1896	7,665,257	24,550
1886	12,266,021	39,181	1897	11,911,766	33,470
1887	10,413,258	35,670	1898	11,068,785	32,792
1888	10,509,799	32,136	1899	11,781,453	32,839
1889	11,190,088	38,968	1900	11,028,337	30,180
1890	15,135,109	57,549	1901	11,625,688	34,087

		Duty.	Pounds.	Value.
1902	Salt, coarse, N.E.S	5c. per 100 lbs.	10,786,285	$25,427
	Salt, fine, in bulk	5c. "	644,372	1,014
	Salt, N.E.S., in bags, barrels or other packages	7½c. "	2,462,192	13,164
	Total		13,892,849	39,605

TABLE 4.

SALT.

IMPORTS—SALT NOT PAYING DUTY.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880	212,714,747	$400,167	1892	201,831,217	314,995
1881	231,640,610	488,278	1893	191,595,530	281,462
1882	166,183,962	311,489	1894	196,668,730	328,300
1883	246,747,113	386,144	1895	201,691,248	332,711
1884	225,390,121	321,243	1896	205,005,100	338,888
1885	171,571,209	255,719	1897	215,844,484	312,117
1886	180,205,949	255,359	1898	202,634,927	293,410
1887	203,042,332	285,455	1899	183,046,365	267,520
1888	184,166,986	220,975	1900	193,554,550	295,253
1889	180,847,800	253,009	1901	216,271,603	339,887
1890	158,490,075	252,291	1902*	238,648,737	385,629
1891	195,491,410	321,239			

* Salt imported from the United Kingdom, or any British possession, or imported for the use of the sea or gulf fisheries.

Producers.

Following is a list of the chief producers of salt in Ontario :—

The Canadian Salt Company, Ltd., E. G. Henderson, vice-Pres., Windsor, Ont.
Saginaw Lumber and Salt Co. . . . . Sandwich, Ont.
Mooretown Salt Co., Ltd. . . . . Mooretown, Ont.
Carter & Kittermaster . . . . " "
Sarnia Salt Co., Ltd. . . . . Sarnia "

SALT.

Producers.

Sarnia Bay Mills Co	Sarnia	Ont.
Cleveland Lumber & Salt Co	"	"
Elarton Salt Works Co., Ltd., C. V. Morris	Warwick	"
Parkhill Salt Co., A. K. Hodgins	Parkhill	"
Exeter Salt Works Co., J. B. Carling, Secy	Exeter	"
Hensall Salt Works, Geo. McEwan	Hensall	"
I. F. Coleman	Seaforth	"
Lake Huron and Manitoba Milling Co., Ltd., P. A. McGaw, Secretary	Goderich	"
R. & J. Ransford	Clinton,	"
Operating the following plants—		
Courtright Salt Works	Courtright	Ont.
Stapleton Salt Works	Clinton	"
North American Chemical Co	Goderich	"
Goderich Salt Works	"	"
Brussels Salt Works	Brussels	"
Clinton Salt Works, John McGarva	Clinton	"
Maitland Salt Works, John S. Platt	Goderich	
The Grey, Young & Sparling Co., of Ont., Ltd., F. G. Sparling	Wingham	"
The Ontario People's Salt & Soda Co., Ltd., Jno. Tolmie, Sec.	Kincardine	"
— Ryghtmeyer	"	"

Deposits.

THE SALT DEPOSITS OF CANADA.

The following extended article has been prepared by Mr. Denis as a result of his observations in the Ontario Salt field supplemented by reference to the available literature of the subject :—

Although a small amount of salt has been produced in Canada from natural brine springs in New Brunswick and Manitoba, these enterprises form quite a minor feature of the industry. In these cases, the salinity of the spring seems to be due to the leaching out by percolating surface waters, of salt scattered through the formation as small aggregations and isolated crystals. The presence of such springs must not therefore be taken to necessarily indicate the presence of extensive salt deposits.

The country's chief resource in this respect consists of the salt beds underlying large areas in Ontario, adjacent to the eastern shores of Lake Huron. The territory, so far proved, has an area of approximately 2,500 square miles fronting on the shore of the lake between Kincardine and Lake Erie, and reaching inland at its greatest breadth to a distance of about 40 miles.

The beds of rock-salt owe their origin to a process of sedimentation and deposition produced by the surface evaporation of bodies of saline water ; such process being comparable to that which produces in warm climates salt by solar evaporation from sea water or other brines. This is at present going on for instance in the Dead Sea, in the Great

Salt lake of Utah and many other bodies of water without outlets, where the quantity of water annually discharged into them, by streams holding salts in solution, is less than the surface evaporation. A similar result happens in the case of basins and bays on the sea coast cut off from the main body of the ocean by sand-bars, etc. Such concentrations of salt waters and eventual depositions from the saturated brines are known to have taken place in most of the geological periods from the Silurian up to the present time, giving rise to the beds of rock-salt which are found in formations of various ages. SALT. Deposits.

From the very nature of the mode of deposition of beds of rock-salt, it can easily be understood that they cannot be expected to be pure sodium chloride. Even the purest ones always contain other salts which may be classified as impurities, such as sulphates and chlorides of calcium, potassium and magnesium.

In some parts of the world the salt deposits occur under such favourable conditions and are so pure that the rock-salt is mined and removed in the solid state. No operations of this kind are, however, carried on in Canada. Where the salt is mixed with layers of rock, gypsum, etc., or is buried at great depths, another mode of extraction is resorted to. Wells or bore-holes are sunk to the salt beds, fresh water is let down and after dissolving the salt, is pumped up in the form of brine; or in certain cases the water infiltrating through the rocks is in sufficient quantity to be taken advantage of as solvent. Both methods are followed in the Ontario field.

Pure water at ordinary temperature dissolves somewhat more than one third its weight of salt, or from thirty five to thirty six hundredths. As results of experiments it appears that 100 parts by weight of pure saturated brine at temperatures of from 32° to 70° Fahrenheit contain from 26·3 to 26·7 parts of salt, the specific gravity of the brine being 1.205 at 60° Fahrenheit. The salometer or instrument used to fix the value of the brines is an aerometer with an arbitrary scale on which 0° represents the density of pure water and 100° the density of saturated brine, both at a temperature of 60° F. The following table gives, in the first column, the degree of the salometer; in the second the degree of Baumé aerometer, which is a hydrometer with an arbitrary scale; the third column the true specific gravity; the fourth, the parts of salt in 100 of the brine; the fifth, the number of gallons of brine required for one bushel of salt. As may be seen these two last columns are based on the supposition that a saturated brine contains 26·5% of salt, which is the quantity arrived at through the further experiments on salt solutions.

Salt Deposits.

Earlier experiments gave as results 25·7% and formerly tables were calculated on that basis. From a practical standpoint, however, it is a question whether the earlier tables are not more accurate if the slight amount of impurities present in the brine is taken into account.—

Salometer degrees.	Baumé degrees.	Specific gravity.	Per cent of salt.	Gallons of Brine for a bushel of salt.
2	.52	1.003	.530	1,264.5
4	1.04	1.007	1.060	629.7
6	1.56	1.010	1.590	418.6
8	2.08	1.014	2.120	312.7
10	2.60	1.017	2.650	249.4
12	3.12	1.021	3.180	207.0
14	3.64	1.025	3.710	176.7
16	4.16	1.028	4.240	154.2
18	4.68	1.032	4.770	136.5
20	5.20	1.035	5.300	122.5
22	5.72	1.039	5.830	111.0
24	6.24	1.043	6.360	101.3
26	6.76	1.046	6.890	93.3
28	7.28	1.050	7.420	86.3
30	7.80	1.054	7.950	80.2
32	8.32	1.058	8.480	74.9
34	8.84	1.061	9.010	70.3
36	9.36	1.065	9 540	66.2
38	9.88	1.069	10.070	62.4
40	10.40	1.073	10.600	59.1
42	10.92	1.077	11.130	56.1
44	11.44	1.081	11.660	53.3
46	11.96	1.085	12.190	50.8
48	12.48	1.089	12.720	48.5
50	13.00	1.093	13.250	46.4
52	13.52	1.097	13.780	44.5
54	14.04	1.102	14.310	42.6
56	14.56	1.106	14.840	41.0
58	15.08	1.110	15.370	39.4
60	15.60	1.114	15 900	37.9
62	16.12	1.118	16.430	36.6
64	16.64	1.123	16.960	35.3
66	17.16	1.127	17.490	34.1
68	17.68	1.131	18.020	33.0
70	18.20	1.136	18.550	31.9
72	18.72	1.140	19.080	30.9
74	19.24	1.144	19.610	30.0
76	19.76	1.149	20.140	29.0
78	20.28	1.154	20.670	28.2
80	20.80	1.158	21.200	27.4
82	21.32	1.163	21.730	26.6
84	21.84	1.167	22.260	25.9
86	22.36	1.172	22.790	25.2
88	22.88	1.177	23.320	24.5
90	23.40	1.182	23.850	23.8
92	23.92	1.186	24.380	23.2
94	24.44	1.191	24.910	22.7
96	24.96	1.196	25.440	22.1
98	25.48	1.201	25.970	21.6
100	26.00	1.205	26.500	21.4

Note.—The above is taken from the table by Dr. Englehardt, published in the New York State Museum Bulletin No. 11 on Salt and Gypsum industries of New York.

As may be observed by a comparison of the above tables of production, the quantity of salt imported into Canada at present, roughly speaking is double the amount produced in the country. This is not owing to a lack of sources from which the whole of the consumption could be derived, but is due to the fact that salt is produced more cheaply in England, from which country the greater proportion of the imports come. This is probably because the extensive salt deposits of Cheshire are in close proximity to the coal supply used for the evaporation of the brine, and also on account of the cheapness of labour. As a measure of protection and help to the Canadian fishery industry, the salt imported for its use is admitted free of duty, and as very low freight rates across the Atlantic can be obtained, salt being carried as return freight and ballast, the whole Atlantic sea board trade is monopolized by English salt. SALT. Deposits.

In a paper on the 'Goderich Salt Region,' published in Vol. V. of the American Institute of Mining Engineers, Dr. T. Sterry Hunt draws a comparison between the Goderich salt and the rock-salt of Cheshire, England, the most productive field of Great Britain. The sample of Canadian salt was broken off the core of the diamond drill hole put down by Mr. Attrill. Pieces of equal size were taken from each linear foot of the white translucent portion, measuring ten feet, of the second bed of salt which has a total thickness of 25 feet 4 inches.

The analysis of English salt made by Dr. Grace Calvert for Messrs. Fletcher & Rigby, is taken from a report to the British House of Commons, in 1873, and is of 'Crushed Marston rock-salt.'

The two analyses are respectively as follows :—

	Goderich.	Cheshire.
Chloride of sodium	99·687	96·70
" calcium	·032	·68
" magnesium	·095	trace.
" potassium		"
Sulphate of lime	·090	·25
Insoluble in water	·017	1·74
Moisture	·079	·63

Deducting the moisture in both cases, the amounts of impurities in the two salts are, Goderich, 0·234 per cent, Cheshire, 2·67 per cent; that is, the English salt contains eleven times more impurities than the Canadian salt.

In the following brief description of the sources of salt in Canada, the deposits are taken up in their geographical order, from east to west, irrespective of their importance from a commercial standpoint.

Salt.

Deposits.

In the provinces of Nova Scotia and New Brunswick, no deposits of rock salt have been discovered, but numerous salt springs are known, to exist the brines of which could be evaporated for salt. These springs are as a rule found in the neighbourhood of the gypsum deposits. Some have been noticed at Pomquets, South river, Brierly brook, Addington Forks, Spring Hill, and other places. They generally take their source in the measures of Lower Carboniferous age.

The manufacture of salt from these brines has been attempted at several places, but in no case does it seem to have been very successful. One of the first attempts was made at Salt Springs, on the West river of Pictou, in 1813. The presence of brine oozing out at the surface was taken as evidence of the presence of a rock-salt bed within easy access, and in the hope of reaching it a shaft was sunk about 200 feet without any results. Some years later the brine itself was used in the manufacture of salt.

Some thirty years ago at Antigonish village, the Nova Scotia Salt Works and Exploration Company put down a bore-hole where the railway station now stands. At a depth of about 159 feet, after penetrating eighteen feet of gypsum, a flow of pure strong brine was started. A plant was erected for the production of salt, and a considerable quantity was manufactured, but the brine eventually became weaker, the original strength having been about 35° of the salinometer. Another bore-hole was sunk, but without satisfactory results, and the enterprise was abandoned.

At Black Brook, Cumberland county, the brine of a spring was used for some time in the manufacture of salt for house use.

At Spring Hill a brine was found recording 30° to 35° of the salinometer; this was also the object of an attempt to manufacture salt.

In New Brunswick, salt springs are known to exist in the vicinity of Sussex and at Saltspring Brook, both in King's county, and on the Tobique river in Victoria county. These springs have their sources in the Lower Carboniferous rocks.

Of the known springs, the Sussex ones are the most important and they are worked intermittently, the product being used locally. These springs were first operated about 100 years ago. There are half a dozen springs within a radius of a quarter of a mile. The brine records 20°. In all cases work is conducted in open pans and wood is used for fuel.

At Salina, King's county, a brine collected from a bore hole 350 feet deep, gave the following results. SALT. Deposits.

	Grains per imp. gallon.
Potassium chloride	19·963
Sodium "	1293·648
Magnesium "	22·315
Sulphate of lime	268·212
" magnesia	11·336
	1615·474

The analysis was made in the laboratory of the Geological Survey of Canada.

In the province of Quebec, although there is an abundance of mineral springs, none of the known ones are suited to the manufacture of common salt. Those in which the proportion of sodium chloride might be sufficient, contain too much earthy chlorides.

The province of Ontario is responsible for almost the total Canadian production of salt, the exceptions being insignificant quantities manufactured intermittently from natural springs for local use only.

The deposits from which this salt is obtained, are found in a basin along the eastern shore of Lake Huron, river and lake St. Clair and Detroit river, and form part of the Onondaga formation of Silurian age. The name of the formation is derived from the county of Onondaga in the state of New York, where these rocks were first studied. In this state this formation had for a long time been known to be saliferous, through the presence of saline springs. In fact, in the "Relations of the Jesuits" as far back as 1646, mention is made of an occurrence of salt springs in the Canton of Onondaga, and the first record of salt manufactured in that region, dates back to 1788, from salt springs, the source of which is the Onondaga formation. It was not until 1865 that this formation was discovered to be saliferous in Canada. The discovery was made accidentally, near the town of Goderich, in a bore hole which was being sunk in search of oil, and which at a depth of 964 feet, struck rock-salt. The boring was continued to 1,010 feet and in that distance passed through 30 feet of rock-salt.

For several years the salt deposits were supposed to be confined to the counties of Bruce and Huron, but they have of late years been recognized to extend south as far as Essex county; the most important salt works in Ontario being now located at Windsor. In the geological column the Onondaga, also called Salina group, is seen

SALT. Deposits.

to be overlaid by the Corniferous and underlaid by the Guelph formation. Its outcrop crosses into Canada from the state of New York at the Niagara river, whence it has a north-west direction to Lake Huron. It dips to the south-west at a very slight angle, so that by boring it is easily reached all along the west shore of the Ontario peninsula, and on the opposite shore in Michigan. The Onondaga includes, both in Canada and New York, beds of gypsum which are worked along the outcrop.

Prof. James Hall in his "Geology of the 4th District" gives the following description of the Salina or Onondaga formation :—"Succeeding the Niagara group is an immense development of shales and marls with shaly limestones including veins and beds of gypsum. The general colour is ashy, approaching drab with some portions of dark bluish green. The lower part is of deep red with spots of green. Succeeding this, where protected from atmospheric influences, the rock is blue like ordinary blue clays, with bands of red or brown. This portion and that succeeding it are often green and spotted, and contain seams of fibrous gypsum, and small masses of reddish selenite and compact gypsum. From this it becomes gradually more gray with a thin stratum of clayey limestone, which is sometimes dark, though generally of the same colour as the surrounding mass. The formation terminates upward with a gray or drab limestone called by Vanuxem the 'magnesian deposit.'" This succession was of course gathered from the outcrops of the formation, hence no rock salt was found in it; on account of its solubility the mineral cannot remain at the surface. It was known, however, even before the actual discovery of rock salt that this formation was the source of the salt springs of the counties of Onondaga and Cayuga, as mentioned by Vanuxem in his "Geology of the third district of New York", but it was only in 1878, that, is more than twelve years after the discovery of the Goderich salt deposits, that rock salt was struck in the state of New York, in the county of Wyoming. As in the case of the Canadian deposit it was found accidentally in the course of a boring for oil.

As mentioned above, the outcrop of the Onondaga in the State of New York runs parallel to the shore of Lake Ontario, and enters Canada at the Niagara river. Its thickness here is estimated at between 200 and 300 feet. In the Geology of Canada 1863, the following short description of the rocks at the outcrop is given :—"The exposures of the Onondaga formation in Canada, so far examined, appear to belong chiefly to the upper portions, from the summit to a little below the gypsum-bearing beds. Those portions consist of

dolomites and soft crumbling shales, which are greenish and sometimes dark brown or bluish in colour, and are often dolomitic. The dolomites are mostly of a yellowish brown or drab colour and are in beds which seldom exceed a foot in thickness. They often exhibit the vesicular or lenticular cavities just described. Some beds of a bluish dolomite are also met with ; and many of the strata both above and below the gypsum, contain such a proportion of clay as make them fit for hydraulic cement. SALT. Deposits.

"The beds of gypsum are never continuous for long distances but appear as detached lenticular or dome-like masses ; the strata above them being arched over and often broken, while those below constitute an even undisturbed floor. The gypsum is inter-stratified with the dolomite and often separated by beds of it. The layers of gypsum may sometimes extend for a quarter of a mile, but they have always been found, on working, to be lenticular in form, and to gradually thin out, until the strata above and below the masses, come in contact. This peculiar structure gives rise to mounds on the surface ; which are regarded by the inhabitants, as indicative of the presence of gypsum beneath."

As shown on the map accompanying the Geology of Canada 1863, the outcrop of the lowest beds of these rocks after entering Canada at a point near Chippawa village, follows along a line parallel to the lake shore to a point some two miles north of Brantford. From here, it follows a direction north north-west as far as the southern part of the township of Amabel, where it takes a sharp turn and goes under the waters of Lake Huron. At almost any place in that part of the province of Ontario west of this boundary, the measures of the Onondaga can be reached by bore holes of various depths after penetrating through the overlying formations. But of this development, only a limited part is salt-bearing. For a long time after the discovery of the salt beds, the saliferous deposits were thought to be limited to the counties of Huron and Bruce, and it was only in 1884 that it was discovered that the salt basin extended south to Courtright, and some eight years later, salt was struck at Windsor in Essex county.

The limits of the saliferous area as it now stands proved are given further on.

It was in 1865 that the salt beds were first struck in the course of a boring for oil at Goderich, Huron county and during several years following this first discovery a certain number of wells were sunk in various places around the town, but the most important to throw light on the stratigraphical sequence of the region, was the diamond drill

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hole put down by Mr. Henry Attrill in 1876, with the view of determining the nature and extent of the salt-beds. The results of the drilling as interpreted from the log and the cores by Dr. T. Sterry Hunt, have been summarized by him as follows :—

	Thickness.		Total depth.	
	Ft.	in	Ft.	in
Clay, gravel and boulders	78	9	78	9
Dolomite, with thin limestone layers	278	3	357	0
Limestone, with corals, chert and beds of dolomite	276	0	633	0
Dolomite with seams of gypsum	243	0	876	0
Variegated marls, with beds of dolomite	121	0	997	0
Rock-salt 1st bed	30	11	1027	11
Dolomite, with marls towards the base	32	1	1060	0
Rock-salt 2nd bed	25	4	1085	4
Dolomite	6	10	1092	2
Rock-salt 3rd bed	34	10	1127	0
Marls with dolomite and anhydrite	80	7	1207	7
Rock-salt 4th bed	15	5	1223	0
Dolomite and anhydrite	7	0	1230	0
Rock-salt 5th bed	13	6	1243	6
Marls, soft, with anhydrite	135	6	1379	0
Rock-salt 6th bed	6	0	1385	0
Marls, soft, with dolomite and anhydrite	132	0	1517	0

The drilling thus showed a total thickness of salt of 123 feet in a distance of 388 feet divided up into six beds, ranging from six feet to nearly thirty-five in thickness. Of these the first bed has intercalated with it layers of dolomite, and is stained by earthy matter. This bed would not be pure enough for mining.

The second and third beds which are separated by a layer of less than seven feet are very pure. They measure together over sixty feet, and represent practically one great mass of rock-salt.

The fourth bed, mesuring from 1207 to 1223 feet is uneven in purity, only the upper two feet and the lower two feet nine inches of the core were saved. The former was somewhat impure, the lower was white salt with layers of dolomite.

The fifth bed measures thirteen and a half feet, and from what can be judged from what was obtained of the core (five and a half feet)the salt is impure though white in portions.

The sixth bed is pure white and translucent and measures six feet.

The limits of the salt basin cannot be shown on the map by a definite sharp boundary, but as far as it now stands proved the land salt area of Ontario is approximately contained within lines joining the towns of Kincardine, Wingham, Brussels, London, Glencoe, Petrolia and a

point a few miles south of Sandwich in Essex county ; on the west it is of course bounded by the shores of Lake Huron, St. Clair river and Detroit river. Salt. Deposits.

It is, moreover, very probable that the greater part of the western peninsula, comprising the counties of Kent and Essex is underlain by salxferous horizons. A bore hole for oil, sunk in the township of Orford, Kent county, is said to have passed through a salt bed of 171 feet in thickness at a depth of 1,510 feet. This assertion would also be confirmed by the fact that in almost all the holes put down in that region great quantities of salt water are struck. The land part of the basin would therefore roughly speaking measure an extreme length of some 150 miles, from Kincardine to Lake Erie with a maximum width of about 40 miles at the center and tapering towards the ends. This would approximately cover an area of over 2,500 square miles.

The salt-beds are supposed to underlie St. Clair lake and river as well as the southern part of Lake Huron as rock-salt is struck in the state of Michigan on the opposite shores, in the same measure. Throughout this region the salt-beds are said to be practically continuous, although there are areas of greater or less extent in which salt-beds are absent ; this is probably owing to inequalities in the sea or lake bottom, which emerged above the waters of the Onondaga period, forming islands, over the surface of which, no salt was being deposited during this period. It would be very difficult to correlate the beds of salt at the different points where they have been struck, without more complete data. A number of logs of wells drilled in different parts of the basin are given below, and also a list of the depths at which salt was struck together with the thickness of rock-salt beds passed through. These with the log of the well, given on page 16 will give an idea of the conditions encountered by the driller in the region.

Logs.

Huron county, Goderich, Attrills bore hole :—
(See page 16.)

Huron county, Brussels :—

Surface	16	feet.
Limestone	100	"
Limestone, magnesian	266	"
Limestone with chert	180	"
Soapstone	353	"
Dolomite, grey	97	"
Dolomite	168	"
Sandstone, dark brown	64	"
	1,244	feet.

(J. Gibson, American Journal of Science, Vol. V, 3rd series.)

Salt. Deposits.

No salt beds of importance were struck in this well, but the record is nevertheless very interesting, inasmuch that at a distance of less than one mile in a direction south-west from it, another well being sunk, struck thick beds of salt. This last well has been a steady producer since then. The north-eastern limit of the salt basin lies, therefore, probably between these two points.

Middlesex county, London Asylum well :—

Surface	130 feet.	
Limestone, hard	200 "	Corniferous.
" soft	270 "	
" hard	100 "	Onondaga with Guelph and Niagara, if present.
"	600 "	
Salt and shale	100 "	
Black shale	200 "	Clinton.
Red "	500 "	Medina.
Limestone and shale	150 "	Hudson river.

(G.S.C. Vol. V., Part Q. H. P. Brumell, Natural Gas and Petroleum.)

Lambton county, Petrolea :—

Surface	104 feet.	
Limestone	40 "	
Shale	130 "	
Limestone	15 "	Hamilton.
Shale	43 "	
Limestone	68 "	
" soft	40 "	
" grey	25 "	Corniferous.
" "	135 "	
" hard, white	500 "	With hard streaks of sand stone from two to five feet in thickness.
Gypsum	80 "	Onondaga.
Salt and shale	105 "	(Including the Oriskany, if present.
Gypsum	80 "	
Salt and shale	140 "	
	1,505 feet	

Elevation above tide, 667 feet.

(G.S.C. Vol. V., Part Q. H. P. Brumell, Natural Gas and Petroleum.)

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Deposits.

Essex county, Windsor, Canadian Salt Works, Well No. 1 :—

Surface	132	feet.
Dolomite	118	"
Limestone (petroliferous)	25	"
Dolomite (marly)	85	"
Limestone (dark petroliferous)	30	"
Dolomite (crystalline)	20	"
Limestone, drab colour	75	"
Sandstone, pure quartzose	55	"
Dolomite, with some gypsum	50	"
" shaly	30	"
" grey and fawn	170	"
" with scales of carbonaceous matter	40	"
" grey	190	"
" shaly, argillaceous	57	"
Rock-salt	40	"
	1,167	feet.

Essex county, Windsor, Canadian Salt Works, Well No. 4 :—

Drift	133	feet.
Limestone	922	"
Salt	30	"
Limestone	25	"
Break in record	35	"
Salt	75	"
Limestone	100	"
Salt	70	"
Limestone	30	"
Salt	252	"
Limestone (ended in)		
	1,672	feet.

(Ont. Bureau of Mines, Sixth Report, p. 33.)

Salt. Deposits.

In the following table is given a list of depths at which salt was encountered at different points in the province, together with the thickness of the salt beds :—

Locality.	Salt struck at depth of.		Thickness of Salt.		
	Feet.	In.	Feet.	In.	
Bruce county, Kincardine :—					
Total depth, 1,007 feet	993		14		
Huron county, Goderich, Attrill's diamond drill :-					
Total depth, 1,517 feet	997		30	11	
	1,060		25	4	
	1,092		34	10	
	1,027	7	15	5	
	1,230		13	6	
	1,379		6		
Huron county, Goderich, International well :—					
Total depth, 1,170 feet	1,054		19		
	1,103		24		
	1,130		32		
Huron county, Wingham :—					
Total depth, 1,185 feet	1,090		30		
Huron county, Brussels :—					
Total depth, 1,244 feet	No salt.				
Huron county, Brussels, ¾ miles south-west of above well :—					
Total depth, 1,000 feet	970				
Huron county, Blyth :—					
Total depth, 1,215 feet	1,125		90		
Huron county, Clinton :—					
Total depth, 1,239 feet	1,151		15		
	1,214		25		
Huron county, Seaforth :—					
Total depth, 1,135 feet	1,035		110		
Huron county, Hensall :—					
Total depth, 1,206 feet	1,090		116		with shale.
Huron county, Exeter :—					
Total depth, 1,251 feet	1,135				
Middlesex county, London, Asylum well :—					
Total depth, 2,250 feet	1,400		100		with shale.
Middlesex county, Glencoe :—					
Total depth, 1,510 feet	1,290		104		with shale.
Lambton county, Port Franks :—					
Total depth, 1,355 feet	1,245		110		with shale.
Lambton county, Petrolea :—					
Total depth, 1,505 feet	1,180		105		with shale.
	1,365		140		with shale.
Lambton county, Courtright :—					
Total depth, 1,665 feet	1,630		22		
Essex county, Windsor :—					
Total depth, Well No. 1, 1,167 feet	1,127		40		
Essex county, Windsor :—					
Total depth, Well No. 4, 1,672 feet	1,055		30		
	1,110		75		
	1,320		70		
	1,420		252		

Manufacture of salt.

The processes used in the production of salt in the Canadian field, are similar to those employed on the Michigan side of the salt area.

These processes may be divided into two general classes differing essentially as to the mode of evaporation of the brine. These are respectively evaporation in vacuum in a closed, air tight vessel, and evaporation in an open pan. Each of these processes may again be subdivided, the first, evaporation in vacuum, into single effect and double effect evaporation; the second into direct fire evaporation and steam evaporation, each of which may be further differentiated according to the apparatus used.

SALT, Manufacture of salt.

VACUUM PAN PROCESS.

Vacuum pan process.

The principle of this process is evaporation in a closed vessel in which a partial vacuum is maintained by means of an air pump. The reduction of atmospheric pressure causes evaporation to take place at a lower temperature; the crystallization is quicker and a finer grain is formed. The heat is obtained by steam entering a closed compartment in the interior of the vessel, in which are sets of copper tubes placed vertically. The steam surrounds these tubes through which the brine circulates. The object of the tubes, which are some five feet long and have a diameter of about three inches, is to give a greatly increased heating surface. When a sufficient quantity of salt has crystallized in the bottom of the vessel it is dumped out on the double bottom principle, without interrupting the evaporation.

The double effect is a modification by which the steam produced by the evaporation of one pan is made to circulate through the steam compartment of a second vessel. In this second vessel the vacuum is kept slightly higher, by which means the boiling point is lower than in the first pan. The principle of the double effect is therefore the use of the steam evaporated from the first pan as source of heat to produce the evaporation in the second pan, resulting in a great saving of fuel.

The only salt plant of this type in Canada is situated at Windsor, Ontario, and is worked by the Canadian Salt Co. This company, up to the present, has been operating two pans of the single effect type, but is now putting in a double effect apparatus which, when completed, will make it one of the best equipped salt manufacturing concerns of North America. The process followed at Windsor is briefly as follows:—

The wells from which the brine is obtained are from 1,167 to 1,672 feet deep, reaching the beds of solid rock-salt. They are cased with a ten inch tubing through the surface deposits; the tubing then narrows down to seven and a half inches, and eventually to six inches down to the salt-bed. Inside of the tubing is a pipe four and a half inches in

SALT.

Vacuum pan process.

diameter reaching down to the rock-salt. A powerful pump forces water down the outer tube; this dissolves the salt, eventually forming large cavities at the bottom of the well offering a great surface of salt to the action of the water. As the rock is not fissured or porous, and the head of the well is made watertight, the water forced downwards in the outer tube is charged to saturation point in the salt cavity and this brine is forced upwards through the inner tube. As a next step the brine flows into large wooden settling vats where it is heated to from 180 to 200° Fahrenheit, and allowed to settle for from twelve to twenty-four hours. By this operation, a great part of the sulphate of lime which is present in the rock-salt and held in mechanical suspension in the brine is deposited on the bottom of the vats. The brine is thus drawn off perfectly clear and limpid, and pumped into the vacuum pan. This large vessel has a cylindrical body with conical top and bottom. Its diameter is twelve feet, and its height about eighteen feet. It is divided horizontally into three compartments. The steam used as the source of heat for evaporation is admitted into the middle compartment, which is some five feet high and is made steam-tight. Passing through this middle compartment are sets of vertical copper tubes, open at both ends and connecting the two other compartments into which the brine is admitted.

Direct steam from the boilers surrounds these tubes, which offer a great heating surface, and through which the brine circulates freely. The vacuum in the pan is maintained by means of a powerful air pump, which at the same time draws off the steam produced by the evaporation. The salt falls to the bottom of the vessel and is emptied by means of a double valve without any interruption in the process. The vacuum is kept at twenty-eight inches mercury, which is very high. The main trouble encountered in this process is caused by the small quantity of gypsum or sulphate of lime contained in the brine. This impurity is deposited in the interior of the tubes, coating them with a layer of non-conducting substance which has to be scaled off about every twelve hours. There are two pans, one being cleaned while the other is in operation. The Canadian Salt Co. is at present putting in very extensive additions to their plant, and when these improvements are completed their works will be better equipped than any other company in America.

The main improvement now being put in, is a double effect vacuum pan, which is said to be the largest in the world for the manufacture of salt. The intention is to use the two single effect pans as first effects. The advantage derived from having two first effect

SALT.

Vacuum pan process.

pans is obvious, as they will be used alternately, one being in operation while the other is being cleaned of the deposit of sulphate of lime. Thus the process will go on without interruption. The second effect pan can run continuously for at least a week without requiring cleaning. The diameters of the first and double effect pans are respectively twelve and twenty feet. The vacuum in the first pan is to be maintained at twenty-four to twenty-five inches, which lowers the boiling point to a temperature of 135° Fahrenheit, and in the second pan at twenty-eight inches, equal to a boiling point of ninety-two degrees.

From the evaporation pan the salt is conveyed to the drying rooms where it is allowed to drain. It then passes into the dryer proper, which is a long wooden cylinder, the axis of which is slightly inclined to the horizontal with cleats and riffles placed longitudinally. Through this, currents of hot air circulate while it revolves, and the wet salt fed in at one end issues at the other end perfectly dry. It then passes through sieves of different sizes according to the grade of salt wanted, the finest passing through a fifty mesh screen.

The process as may be seen is very simple and yet very efficient. The Windsor plant compares very favourably with any plant on this continent. The steam is provided by two sets of boilers equipped with mechanical stokers, and capable of developing 1,700 horse power.

The capacity of the plant is at present 1,000 barrels a day ; this, when the present improvements are completed, will be increased to 1,500 barrels per day. The present cooperage can turn out from 1,000 to 1,200 barrels a day.

STEAM EVAPORATION IN OPEN AIR. GRAINER AND RAKER PROCESS.

Steam evaporation in open air grainer and raker process.

This process was originally developed in Michigan and in that state is the one most used. In Ontario there are only three plants of this type now in operation, but the present tendency is toward a more extended use of this process and the abandoning of the more primitive direct fire manufacture.

The principle is simple in the extreme. The brine is pumped from the well into large wooden vats or tanks where it is heated and allowed to settle. Then it passes into the grainer proper. This consists of a long shallow vat made generally of boiler plates. The dimensions of the average grainer are 150 feet long by from 10 to 14 wide, and about 2 feet deep. Throughout the whole length of the vats are a number of steam pipes suspended by hangers, so as to leave the bottom smooth and clear of obstruction. One end of the

SALT.

Steam evaporation in open air grainer and raker process.

vat is sloping at an angle of about 20°, forming an apron. The brine, which is first heated in the settling vats is allowed to flow continuously into the grainers, where the level of the liquid is kept constant, at from 15 to 20 inches in depth. The evaporation causes the salt to crystallize, and settle over the bottom of the tanks. The steam used in the pipes of the grainer is, as a rule, live steam or direct from the boiler. To get as much efficiency as possible, the exhaust steam from these pipes is used to heat the brine in the settling tanks. To remove the salt from the grainers, a very ingenious device is used. It is a mechanical rake consisting of two endless chains running along the whole length of the grainer (from 140 to 160 feet) near the sides, over sets of rollers on horizontal axes. At equal intervals are fastened on these chains, vertical narrow blades, four or five inches wide, covering the entire width of the bottom of the vat. These blades, scraping up the salt as it forms and settles, bring it up the incline or apron at one end, giving the crystals a preliminary draining, then drop the salt on a draining and drying floor whence it is shoveled into bins.

At Kincardine a modification of this process is used which is called the "V" system. The only difference is in the shape of the graining vats. In the V system these graining vats have sloping sides in the shape ofthe letter V, and the salt when formed, falls to the bottom, which is made in the shape of a rectangular trough twelve inches wide by ten to twelve inches deep. The raker travels in the trough, its dimensions being modified accordingly.

The grainer process is the favourite one in Michigan, and is at present spreading throughout the Ontario salt district. In several cases it is used by large lumber companies, who take up the manufacture of salt as a subsidiary industry, to use up the surplus and exhaust steam of their saw mills.

The process requires very little labour; the installation of the plant is more costly than the old direct fire method; but in the case of the lumber companies as the steam plant is primarily erected to supply the saw mills, very little extra expense in the boiler house is needed to supply the salt plant, and the two industries certainly go very well hand-in-hand.

Other steam evaporation processes.

OTHER STEAM EVAPORATION PROCESSES.

In other cases, the steam instead of being conveyed through pipes to evaporate the brine, is simply made to enter a false bottom under the evaporating vats. This is the case with a plant at Goderich, that of the Lake Huron and Manitoba Milling Co., who use the exhaust

and surplus steam of their mill No mechanical rakers are used in this plant, the salt being removed with hand rakes. The output of this plant is at present one hundred barrels a day, but extensions are now in progress which, when completed, will double its capacity. SALT.

EVAPORATION BY DIRECT FIRE.

Evaporation by direct fire.

A plant of this type consists, besides the brine pumping apparatus, of settling tanks, evaporating pans and floor space to drain and pack the salt. The pans are as a rule 100 feet long by 20 to 25 feet wide and 12 to 14 inches deep ; they are made of boiler plate, one quarter of an inch thick, and supported by walls which serve as sides to the fire grates and as horizontal flues along the whole length of the bottoms of the pans. These pans are made with the sides slanting forming a draining apron, on which the salt is raked from the bottom of the pans, as it crystallizes and deposits there. It is then stored in bins and packed in bags or barrels for shipment.

The plants using direct fire evaporation are, of course, the least costly to install and this type of manufacture is greatly used in the Ontario field. The capacity of the average plant is from 100 to 125 barrels of coarse salt per day. For this output from six to eight tons of coal is required, and seven to ten men.

There are at present twenty-one plants in the Ontario field, some of these run continuously and others only at intervals. Of these plants, sixteen use the direct fire evaporation, four have steam evaporation in open air, and one uses the vacuum process. The majority of these plants produce only the coarse packing salt. In fact only three plants in the whole district manufacture the finer grades of salt, which are classified as table, fine, dairy and cheese, according to their fineness. For the production of the better qualities, extra care has to be taken in the handling of the brine and of the salt. This has, moreover, to be dried artificially, and passed through the different mesh screens. There have been no attempts made towards mining rock salt in the district, but a company is at present sinking a shaft on the American shore of the Detroit river, some four miles below the city of Detroit. They hope to strike the first bed of salt at 800 feet. The progress of the enterprise will be watched with great interest.

A list of the plants operating in the Canadian field is given below :— Plants operating.

Location.	Operated by.
Blyth	Young & Sparling.
Brussels	Coleman Salt Co.
Clinton	R. J. Ransford.
Courtright	" "

SALT.

Plants operating.

Location.	Operated by.
Exeter	Exeter Salt Co.
Goderich	North America Chemical Co.
"	Lake Huron & Manitoba Milling Co.
"	Peter McEwan.
Hensall	Geo. McEwan.
Kincardine	Rightmeyer Salt Co.
"	Ontario People Salt Mfg. Co.
Mooretown	Mooretown Salt Co.
"	Carter & Kittermaster.
Parkhill	Parkhill Salt Co.
Sarnia	Sarnia Salt Co.
"	Sarnia Bay Mills Co.
Sandwich	Saginaw Lumber & Salt Co.
Wingham	Young & Sparling.
Warwick	Elarton Salt Co.
Windsor	Canadian Salt Co.

Analyses.

ANALYSES OF BRINES.

—	Sodium Chloride.	Calcium Chloride.	Magnesium Chloride.	Sulphate of Lime.	Specific Gravity.	Degrees of Salometer.
Goderich, sample taken August 19, 1866	259·00	·432	·254	1·882	1·205	100
Goderich, same well as above, November 5, 1868	236·410	·190	·410	4·858	1·187	92
Clinton well	204·070	·470	·184	5·583	1·157	80
Kincardine	241·350	·840	·230	3·264	1·191	94

Analyses by Dr. T. Sterry Hunt, laboratory, Geological Survey of Canada. Figures are per 1000 parts by weight.

ANALYSES OF SALTS.

—	Sodium Chloride.	Magnesium Chloride.	Calcium Sulphate.	Water.	Insoluble.
Goderich (fine table salt)	98·4238	0·0915	1·0426	0·6483	0·4200
" (fine salt)	98·0947	0·0010	1·2574	1·2610	....
" (coarse)	97·3039	0·0436	1·4316	0·6454	....
Clinton (fine salt)	98·5743	0·1368	1·1554	0·7944	0·0600
" (coarse)	97·4756	....	1·3899	0·9830	0·2200
Seaforth (dairy salt)	98·7393	0·0168	1·3642	0·3289	0·0170
" (fine salt)	97·8401	0·0480	1·1568	0·9095	0·0150
" (coarse)	98·2778	0·0078	1·2515	0·6832	0·0160

The above analyses of salt were made by Dr. Ellis, of Toronto.

The salt from which these samples were taken in all cases is manufactured in open pans.

In Michigan the salt industry is well developed along the St. Clair and Detroit rivers. The salt is derived from the beds of the same formation as in Ontario. For the purpose of comparison the depths at which rock-salt is reached at different points in Michigan and the thickness of the beds are given below : SALT. Salt industry in Michigan.

	Salt struck at depth of	Thickness of salt.	
Wayne county—Wyandotte......	800 feet.	30 feet.	
	940 "	15 "	
	1,120 "	70 "	
St. Clair county—Algonac........	1,562 "	52 "	
" " 5 miles below town................	1,500 "	80 "	salt and shale mixed.
	1,605 "	18 "	
	1,633 "	94 "	
St. Clair county—St. Clair.......	1,630 "	30 "	
" Marine city....	1,700 "	over 100 "	
" Port Huron....	1,700 "	60 "	stopped in rock-salt.
Oakland county—Royal oak......	1,540 "	97 "	
	1,650 "	45 "	
	1,735 "	57 "	
	1,820 "	80 "	
	2,005 "	15 "	
	2,115 "	35 "	
	2,165 "	20 "	
	2,200 "	100 "	
	2,315 "	160 "	

Besides the beds of rock-salt, there is another source from which salt is manufactured in Michigan. This is the brine which is found in the porous beds at the base of the Carboniferous measures, and until the discovery of the rock-salt, which, in Michigan was later than in western Ontario, this brine was the only source of salt.

As mentioned before, no mining of the rock-salt beds is at present carried on ; but an attempt is now being made on the shore of the Detroit river a few miles below the city of Detroit, to reach the first bed of salt by a shaft with a view to working it by mining methods. It is expected that the bed will be met with at a depth of 800 feet.

In Manitoba some brine springs have been worked for some length of time, supplying a small local demand. On the north-western part of Lake Winnipegosis, at Salt Point, near the mouth of Bell river, which empties into Dawson bay, salt was manufactured many years ago. The most important salt springs area, however, is that on Red Deer peninsula, in the southern part of Winnipegosis Lake. This was the scene of salt manufacture as early as 1820 or thereabouts, when James Monk- Manitoba.

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Manitoba.

man began working these springs. In every case, however, the process used was primitive, and the salt only used to supply local demands. After James Monkman, his sons took up the work, and in 1858, according to Professor H. G. Hind, they were carrying on the industry with profit.

Mr. J. W. Spencer, in the report of the Geological Survey of Canada for 1874-75, gives a short description of how the manufacture was carried on at the time of his exploration in that district :

"The manufacture of the salt is conducted in a rude manner. Pits are dug four or five feet deep, and into them the waters infiltrate. Beside these, temporary furnaces are erected, on which are placed evaporating pans made of iron plate one-eighth of an inch in thickness and five or six feet long, by about three feet wide and eight or ten inches deep. Beside the pans, are trays into which the salt is raked. No pumps are used, the water being lifted into the pans directly from the pits by means of pails. The operation is conducted entirely in the open air. The manufactured salt is put into birch-bark boxes, or "mococks," holding about 100 pounds each, and is then ready for market. During the season Mr. McKay, the only person engaged in the business, made about 500 bushels, or less than half the quantity which had been manufactured in some previous years.

"The following is an analysis, by myself, of a sample of the salt which I brought from the works.

Sodium chloride	95·123
Magnesium chloride	0·600
Calcium sulphate	3·400
Sodium sulphate	0·394
Moisture	0·044
Residue	0·439
	100·000

"The residue consists of silica, alumina, iron and lime. The salt has a light brown tint, and is very coarse grained, owing to the manufacturer allowing the crystallization to go too far undisturbed."

J. B. Tyrrell, in his report on North-western Manitoba, (Geological Survey of Canada, 1890-1891, Part E), gives the following list of points where brine springs were observed :—

Salt Creek, west of Lake Dauphin.

Banks of Mossy river.

Salt Point, south of Lake Winnipegosis.

Monkmans Salt Springs, Red Deer peninsula. SALT. Manitoba

Pine Creek.

Pelican Bay, mouth of Pelican creek.

Pelican Bay, west side.

Mouth of Bell river.

Salt Point.

Salt Point peninsula, with salt area near its base.

Salt Point peninsula, north side of its base.

Mouth of Steep Rock river.

Lower Red Deer river, many places.

Banks of Shoal river.

Mouth of Swan river.

These according to the same authority have their source chiefly in the Devonian rocks, although salt is not absent from the beds of Silurian age. The salt of these brine springs seems to be derived from crystals occurring scattered throughout the rocks rather than from beds of pure rock-salt, for impressions of salt crystals are very common in the dolomites, whereas no indications were observed from which the presence of rock-salt could be surmised. In some cases the crystals are so numerous that salt must have been present to the amount of one-third of the whole mass. As a rule the brine is not strong, but occurs in very large quantities.

Samples were collected and analyzed in the laboratory of the Geological Survey of Canada and from these tests the following table has been made up :—

SALT.

Analyses of brines from Manitoba.

ANALYSES OF BRINES FROM MANITOBA.

The following table shows the number of grains per Imperial gallon of each of the chief constituents :—

Constituents.	1	2	3	4	5	6	7	8	9	10	11	12
Chloride of Sodium..	3426.61	2777.44	3402.38	3716.73	3884.57	3673.23	6024.98	3233.15	3709.59	1873.78	1347.08	3099.41
" of Potassium.	163.86	114.59	209.39	180.21	137.90	14[illegible].16	86.17	138.81	179.86	150.16	48.72	23.11
" of Calcium..	....	28.45	....	....	....	7.87	....	10.43	....	15.67	....	44.05
" of Magnesium	77.17	101.16	101.75	85.69	47.43	94.66	125.46	78.03	81.46	79.84	58.53	142.22
Sulphate of Lime....	285.83	233.72	296.23	304.96	272.81	300.30	425.25	281.90	308.38	205.53	204.83	252.71
" of Magnesia.	3.42	....	1.24	6.49	57.30	....	19.42	....	10.98	....	10.95	....
Total	3956.89	3255.37	4010.99	4294.08	4400.01	4221.22	6681.28	3742.32	4290.27	2324.98	1670.11	3561.50
Specific gravity......	1.039	1.032	1.039	1.041	1.044	1.041	1.063	1.035	1.039	1.022	1.016	1.035

1. Spring on the south bank of Red Deer river, four miles from Lake Winnipegosis. N. lat. 52° 52′ 30″; W. long. 101° 5′. Flow 10 gallons a minute, collected 9th Sept. 1889.

2. Lower Salt spring, on the north side of Red Deer river, a mile and three quarters above its discharge into Lake Winnipegosis. N. lat. 52° 53′ 20″; W. long. 101° 2′ 15″. Flow 2 gallons a minute. Collected, 13th August, 1889.

3. Spring near the west shore of Dawson Bay, Lake Winnipegosis, three quarters of a mile north of Steep Rock river. N. lat. 52° 48′ 30″; W. long. 100° 57′. Flow 4 gallons a minutes, Collected, 6th August 1889.

4. Spring on a hill side near the shore of Dawson bay, Lake Winnipegosis, at a point two miles east of the mouth of Steep Rock river. N. lat. 52° 48′ 30″; W. long. 100° 0′ 57″. Flow 25 gallons a minute. Collected August 8th 1889.

SALT.

Analyses of brines from Manitoba.

5. Salt Point, on the south-west shore of Dawson Bay, Lake Winnipegosis. N. lat. 52° 48′; W. long. 100° 48′. Flow $1\frac{1}{2}$ gallons a minute. Collected August 3rd, 1889.

6. Spring on the west side of Dawson Bay, Lake Winnipegosis, three miles and a half north of the mouth of Bell river, and a mile back from the lake shore. N. lat. 52° 48′; W. long. 100° 51′ 20″. Flow 20 gallons a minute. Collected 2nd August 1889.

7. Brook flowing into the west side of Dawson Bay, Lake Winnipegosis. N. lat. 52° 47′ 40″; W. long. 100° 51′. Flow 60 gallons a minute. Collected 1st August 1889.

8. Spring half a mile back from the west shore of Swan lake, between it and the lower portion of Swan river. N. lat. 52° 26′ 35″; W. long. 100° 42′ 45″. Flow 5 gallons a minute. Collected August 31, 1889.

9. Spring on the shore of Pelican Bay, Lake Winnipegosis, just east of the mouth of Pelican river. N. lat. 52° 38′ 30″; W. long. 100° 21′. Flow 25 gallons a minute. Collected 21st July 1889.

10. Spring on the west side of Pine Creek, near its discharge into Lake Winnipegosis. N. lat. 52° 1′; W. long. 100° 8′. Collected 6th July 1889.

11. Monkman's Salt Springs, on the west shore of Lake Winnipegosis. N. lat. 51° 45′; W. long. 99° 56′ 40″. Collected 1st July 1889.

12. Monkman's Salt Springs, an old well a few yards from the spring from which No. 11 was obtained. Collected 1st July 1889.

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Manitoba.

Of these brines, Dr. G. C. Hoffmann reports as follows :—"The proportion of foreign saline matter in these brines is not excessive and if certain purifying processes are had recourse to, there is no reason, local conditions being favourable, why they should not be utilized in the manufacture of salt."

At present the industry is carried on at intervals on a small scale supplying only local demand. J. B. Tyrrell describes the saline areas as follows:—"The characters of these saline areas are very similar throughout, and the descriptions already given of those on Pelican bay and other places might suffice for all. They are generally barren tracts several acres in extent, surrounded by a fringe of the red salt plant (*Salicornia herbacea*). Here and there springs bubble up and often build rounded mounds of reddish scinter, several feet in height, in the centre of the tops of which, over the springs, are little basins of clear brine. Down the sides of these mounds the water trickles to the arid flats, where it evaporates in the dry seasons. In other places the pool of salt water is in the middle of a little tract of soft mud, over which may be a sod of coarse grass. In the pool bubbles of gas are constantly rising. This gas was found to be uninflammable, and was probably to a large extent composed of air."

Assiniboia.

Further west in the Assiniboia district, saline lakes occur. Mr. R. G. McConnell reports the presence of a great many of these in the plain north, stretching from the escarpment which ends the Cypress Hills on towards the Saskatchewan River. These lakes are of all sizes, among the largest are Many Island lake, Crane lake, Big Stick lake. "The lakes vary through every degree of salinity, from those covered with a thick crust of crystallized salts down to others in which the water is perfectly fresh, and the two extremes are not infrequently met with side by side."

SALT.

BIBLIOGRAPHY.

Bibliography.

BAILEY, L. W.—Rep. Geol. Surv. of Canada, Vol. X, 1897, part M, The Mineral Resources of the Province of New Brunswick.

BRUMELL, H. P. H.—Rep. Geol. Surv. of Canada, Vol. V, 1890–91. Part Q, Report on the Natural Gas and Petroleum in Ontario.

FLETCHER, HUGH.—Rep. Geol. Surv. of Canada, 1886, part P. On Geological Surveys and Explorations in counties of Guysborough, Antigonish, Pictou, Colchester and Halifax, Nova Scotia.

HOFFMANN, G. C.—Report Geol. Surv. of Canada, Vol. V., 1890–91. Analyses of Brines from Manitoba.

HUNT, T. S.—Geol. Surv. of Canada, Report of Progress, 1865-66. Geology of Petro leum and Salt.

HUNT, T. S.—Geol. Surv. of Canada, Report of Progress 1866–69. On the Goderich Salt Region.

HUNT, T. S.—Geol. Surv. of Canada, Report of Progress 1876–77. The Goderich Salt Region.

HUNT, T. S.—Trans. Am. Inst., Mining Engineers, Vol. V. On the Goderich Salt Region.

INGALL, E. D.—Rep. Geol. Surv. of Canada, Vol. I, (N.S.), 1886, Part S on Salt.

LANE, A. C.—Geological Survey of Michigan, Report for year 1901.

McCONNELL, R. G.—Rep. Geol. Surv. of Canada, 1885, part C. On the Cypress Hills, Wood Mountain and adjacent country.

MERRILL, F. J. H.—Bulletin of the New York State Museum, Vol. III, No. 11, Salt and Gypsum industries of New York.

MINERAL INDUSTRY.—Technology and Trade, New York, Vols. I. and II.

MINES SECTION.—Reports Geol. Surv. of Canada, Vol. IV., 1888–89, Vol. V., 1890–91; Vol. VI., 1892–93; Vol. IX., 1896; parts S. Salt, statistics and developments of the industry.

ONTARIO BUREAU OF MINES.—Reports of: Vol. I., 1891; Vol. IV., 1894; Vol. VI., 1896; Vol. IX, 1899.

SMITH, J. S.—Geol. Surv. of Canada, Report of Progress, 1874–75. History and Statistics of the Trade and Manufacture of Canadian Salt.

SPENCER, J. W.—Geol. Surv. of Canada, Report of Progress, 1874–75. On the Country between Upper Assiniboine river and Lakes Winnipegosis and Manitoba.

TYRRELL, J. B.—Rep. Geol. Surv. of Canada, Vol. V., 1890–91, Part E. Report on Northwestern Manitoba.

WRIGHT AND LANE.—Geology of Lower Michigan, with reference to deep borings. Geological Survey of Michigan, Vol. V.

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